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ABSTRACT

Three new teaching techniques, using established principles of learning, were combined to teach an introductory digital computer course to college students. The techniques were: 1) programed instruction; 2) Fields-type teaching tests, "a discrimination method to teach concepts by modifying the examination procedure to emphasize similarities rather than differences," and 3) the proctorial system of instruction (PSI), or self-paced instruction. At the completion of the course, 86 percent of the students said they preferred this system to conventional lecture. Advantages of this method are that students appear to learn more, use of proctors is less expensive than use of instructors, and materials can be developed by the teacher while he is teachin the course. (JK)

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INTEGRATION OF THREE NEW TEACHING TECHNIQUES IN AN INTRODUCTORY COMPUTER COURSE[1]

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Three new teaching techniques, using established principles of learning, were combined Spring Quarter 1971 to teach a three-credit introductory digital computer course to four sections (25 students in each) using ten student proctors. One technique, first used alone in 1967, was Skinner-type programmed or self-instruction. The writer attended the ASEE sponsored PI Workshop at the University of Colorado during the summer of 1965, and worked three years developing a programmed self-instruction text[2]. Used alone, students could and did learn the Fortran language, but the course was somewhat stale and motivation was lacking for some students.

The second technique used was developed by Dr. Paul E. Fields, Psychology, University of Washington, and is known as Fields-type teaching tests (or questions)[3]. A comprehensive set of Fields-type questions covering the language concepts of Fortran was written, tested and rewritten in 1968 and 1969. This technique was combined with programmed instruction in 1969, and the two techniques have been used regularly since that time. To quote Dr. Fields, "The tests are a discrimination method to teach concepts by modifying the examination procedure to emphasize similarities rather than differences, and by minimizing the possibility of a successful response by chance." Dr. Fields found, as did the writer, that 90% of the students using the technique like it, that grades can be assigned on perfection rather than on the

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"normal distribution" curve, and grades assigned are considerably higher than for conventional techniques of teaching. With experience and skill, an instructor preparing such tests can consider performance or behavior objectives, criterion tests, and can incorporate important parts of the Skinner technique. (The Fields technique is explained in detail in Dr. Fields' text, as well as in three programmed self-instruction units prepared by the writer[4].) Although the questions require considerable time and effort to prepare, a competent secretary can not only grade such tests, but can also rearrange the association items and retype them for subsequent use the following quarter. They are so constructed that they cannot be memorized, so a set can be given to students to study; then, after rearranging, used again for testing. One of Dr. Fields' findings was that frequent (weekly) testing improved achievement, particularly for slow learners.

The third technique integrated into the course was the proctorial system of instruction (PSI), also called self-paced instruction, and was developed by psychologists Fred S. Keller and T. G. Sherman[5]. The writer attended a workshop conducted by Keller, Koen, and Stice at the ASEE Annual meeting at Ohio State University in June 1970; a second one at the ASEE Annapolis meeting in 1971, and another one on the construction of behavioral objectives conducted by Dr. Edwin B. Kurtz at the University of Washington in February 1971. Unit objectives and assignments were prepared and used with the PSI, incorporating the programmed text and the Fields technique during Spring Quarter 1971.

Ten student proctors (mostly undergraduate)[6], each working six hours per week and receiving $2.25 per hour, were used for individual instruction as requested by students, and for administering, grading, and recording achievement

quizzes. The writer was given one-third time for managing or coordinating the instruction, and one instructor devoted half-time to general assistance and preparation of quizzes and the final examination. At least two student proctors met with each section twice a week for 50-minute periods. Proctors were also available in scheduled rooms for administering quizzes three hours Tuesday morning and two hours Thursday afternoons. The Keller technique allows students to proceed at their own rate, turning in a computer program, taking the achievement quiz, and receiving a grade of at least 90%[7] on all work for each unit. Three sets of quizzes were prepared and used with each unit, and each set consisted of two parts: (1) about 20 Fields-type questions on the Fortran language, and (2) construction of a flow chart and/or computer program.

The point system for assigning grades was based on 11 processed computer programs of 50 points each, 10 achievement quizzes at 50 points each, and a final exam of 200 points. Grades were assigned on the basis of less than 60% - E, up to 69% - D, up to 79% - C, up to 89% - B, and 90% or above - A. Grades earned on this basis were: A - 63%, B - 5%, C - 5%, D - 2%, E - 3%, passing withdrawals - 16%, incompletes - 7%. Students receiving less than an A did not complete all of the units, although a few students were taking the course pass-fail and did not attempt to complete all units. A passing withdrawal was allowed anytime during the quarter, and the 16% passing withdrawals was about twice as high as for regular classes.

Following is a summary of the evaluation of the course and the professor which was made by 71 students. The writer feels this experiment, using Fields technique, programmed self-instruction, and the Keller PSI was 86% successful - based on the response to question #16. Eighty-six percent of the students stated they preferred this system to conventional lecture. It is believed

that with several obvious improvements, as well as several suggested by students, that the system can be at least 90% successful." Questions 12, 13, 14, and 15 were taken from similar questions asked by Dr. Keller in one of his evaluations. Note that only 3 to 4 students indicated "less than" when comparing self-paced instruction to the lecture method on each of the four questions. Most students believed other courses could also be taught using the proctorial system as indicated by question 17.

A short evaluation form on the proctors was also completed, with students grading them A, B, C, D, or E on sincerity, concern and interest, competence, and a final grade for the course. All proctors received nearly identical ratings, and the responses were mostly A's with some B's, and were higher than the grades received by the writer.

Some of the things that need improvement (and more work) are: (1) the work load was too much for three credits (and is being changed to four); (2) some of the Fields questions were ambiguous and need revision; (3) the unit objectives and assignments were too variable in length, particularly the last few which were much too long (the ten units have just been revised into 18 units and copies are available from the writer); (4) better security is needed in administering quizzes as some cheating was reported by students; (5) better overall organization and coordination is needed (this comes with experience); (6) more discussions are needed with proctors to make them aware of the "pressure" from a few students. (The pressure was particularly heavy the last few weeks of the quarter when students were trying to complete all ten units.)

What are the disadvantages of using the techniques described with 100 students? The primary one felt by the writer was the loss of direct contact, and the inability to "know" 25 students, and being able to call them by name

when meeting anywhere on campus. There was also loss of ego and importance in the classroom because the writer was not needed there after the first few classes. The former "teaching" role became one of a manager, coordinator, or an arranger of instruction for 100 students, and to quote Dr. Keller, he "arranges the contingencies of reward essential to the learning process."

The writer agrees with Dr. Keller that about 100 students and 10 proctors is the limit for one instructor to manage using the PSI. However, because the various teaching materials and method developed for this course over the last six years were cumulative in results (and not "forgotten," such as after a lecture), about $1,150 can be saved each quarter by using the proctorial system with 100 students. This is based on the assumption that a full-time teaching load for an instructor making $1,500 per month, using conventional lecture, would require 1-1/3 instructors and cost $6,000. Using the proctorial system with one instructor as a coordinator one-half time would cost $2,750; plus one secretary, one-half time, at a cost of $900; ten proctors at 5 hours per week, $2.25 per hour, 10 weeks per quarter, at $1,125; extra supplies at $75; for a total of $4,850. The amount saved is the difference between $6,000 and $4,850, or $1,150 per quarter. In addition to the money savings most students like the technique better than conventional instruction, and the writer believes students learn more.

Does a professor interested in improving the teaching-learning process have to take a year or two off to prepare such materials? Or can a teacher incorporate parts of these techniques each quarter or semester? The answer to the first question is obviously "yes, desirable, but ordinarily not possible." The writer feels that small steps can be taken, using established principles of learning[8]. Professor Ed Kurtz suggests that a start can be made by a teacher who uses conventional lecture by taking 15 minutes before each class

to write down behavior objectives, and then preparing achievement quizzes based on these objectives. The goal stated in his manual is:

> "You will be able to construct instruction for your college courses that is based on behavioral objectives - what does that mean in practical terms? It means that you will be able to write objectives for your lectures and also design the lectures so as to increase the likelihood that students will learn. It also means that you will be able to write objectives, problems, and matching test items for printed materials such as textbooks, manuals, films, and other audio-visuals. It also means that you will be able to devise totally new materials, based on behavioral objectives, for group or individualized instruction. Whatever kind of instruction you want to use, you will be able to use objectives to build in it accountability, and, hopefully, increase student success."(9)

The writing of good behavioral objectives is essential when using PSI.

The writer feels that good weekly 20 to 30 minute quizzes will do much to increase achievement and help the teacher and student determine whether or not the behavioral objectives are being met. A start can also be made by selecting a difficult topic within a course and developing good instructional materials for it. Quite a few engineering professors throughout the country have prepared such materials and they should become available to others soon(10). If proctors and secretarial assistance are not available the writer has modified the Keller technique by giving achievement quizzes at one predesignated time only, and providing for one additional quiz at another designated time for those failing. This does require that each student get "ready" for each achievement quiz within a designated period of time, usually one

week -- which means some students might require as little as 5 hours while slow students might require 12 hours to prepare for the same unit.

However, professors should have as their final goal the development and/or adaption of the complete system. The basis of the Keller system, in summary, is that to modify behavior students (1) must respond (not just listen), (2) receive positive reinforcement, rather than negative, (3) progress at their own rate, (4) prove achievement and mastery with unit quizzes (which also provides for feedback to correct mistakes and fill gaps), (5) learn from written and visual materials rather than the spoken word, (6) receive the material in relatively small logical parts, (7) have the use of student proctors for providing individual assistance, and for administering, grading and recording grades.

SUMMARY(1)

EVALUATION OF COURSE AND PROFESSOR - GE 115, Spring 1971

Section____ _____
(your name, optional)

Please check the appropriate box:

	Too Little	About Right	Too Much
1. I believe the amount of work assigned for 3 credits was:		31-44%	40-56%
2. I believe the number of achievement quizzes given was:	1-1%	60-85%	10-14%
3. I feel the number of computer programs written and processed was:	3-4%	36-51%	32-45%

	Excellent	Good	Fair	Poor	No Response
4. My feeling about the use of Fields-type teaching questions is that they were:	26-37%	28-39%	12-17%	6-7%	
5. My feeling about the use of other short quizzes (flow charts and programs) is that they were:	13-18%	44-62%	12-17%	2-3%	
6. My feeling about the Unit Assignments (Performance, Conditions, Criterion) is that they were:	16-23%	42-59%	10-14%	2-3%	1-1%
7. My feeling about the programmed self-instruction book used is that it is:	27-38%	26-37%	13-18%	5-7%	
8. My feeling about the relevance of the material in this course as related to my future use is that it is:	16-23%	44-62%	8-11%	1-1%	2-3%

(1) The first number in each box indicates the number of students answering the questions, and the second number is the percent of students answering.

The grade I feel the professor earned for each of the following is:

	A	B	C	D	E	No Response
9. Design, arrangement, organization of course:	41-58%	24-34%	4-5%	2-3%		
10. Techniques used in assigning grades:	45-64%	21-30%	4-5%	1-1%		
11. The final grade I assign the professor in charge of this course is:	43-61%	21-30%	5-7%	1-1%		1-1%

	Much Greater	Somewhat Greater	About the Same	Less Than	
12. I believe the amount of mastery (things actually learned) using the self-paced technique, as compared to the usual lecture method of instruction was:	24-34%	30-42%	14-20%	3-4%	
13. I believe the feeling of achievement using self-paced instruction, as compared to the lecture method, was:	25-35%	30-42%	13-19%	3-4%	
14. Insofar as recognition of the student as an individual is concerned, I feel that self-paced instruction, as compared to the conventional lecture, was:	29-41%	24-34%	13-18%	4-6%	1-1%
15. The amount of enjoyment and satisfaction I received in taking this course by self-paced instruction, as compared to the lecture method was:	31-44%	27-38%	10-14%	3-4%	

16. If there was a choice, would you recommend to a friend that he or she take this course by:

    a. ☐ Conventional lecture, by a professor (10-14%)

    b. ☐ Self-paced instruction, using undergraduate proctors (61-86%)

17. Do you believe other courses could and should be taught by self-paced instruction? If so, place a check in front of those you think you would prefer to take by this technique:

☐ other computer courses 52-73%	☐ mathematics 40-56%	☐ chemistry 35-49%	
☐ graphics 19-27%	☐ physics 32-45%	☐ English 13-18%	☐ humanities courses 10-14%
☐ social scinece area 8-11%			
☐ other:_____			

Please use the reverse side of this sheet to make any comments or suggestions, good or bad, about the questions above, or anything else, that will help to improve this course.

References:

(1) Presented at the ACADENOS program at the Annual Conference, ASEE, United States Naval Academy, Annapolis, Md, June 22, 1971.

(2) INTRODUCTION TO DIGITAL COMPUTER PROBLEMS USING FORTRAN IV, Walter L. Dunn, McGraw-Hill Book Co., 1969.

(3) FIELDS TEACHING TESTS TO ACCOMPANY "PSYCHOLOGY AND LIFE, 8TH EDITION," Paul E. Fields, Scott, Foresman and Co., 1971.

(4) "How to Answer and Construct Fields Type Teaching Questions," Walter L. Dunn, unpublished.

(5) "Good-bye Teacher. . . ," JOURNAL OF APPLIED BEHAVIOR ANALYSIS, Spring, 1968, I, pp. 79-89.

(6) Dr. Keller states peer teaching is effective because students who have just completed a course are better able to relate to and understand questions of other students. He also believes that, in general, undergraduates make better proctors than graduate students.

(7) Dr. Keller recommends "unit perfection as the basic condition of advancement," rather than a criterion such as 90%. In this particular course it was decided that minor mistakes, such as misplacing a heading on a computer printout by one or two columns, or omitting a parenthesis or period in a Fortran program (hand-written), were insignificant insofar as the objectives of the unit were concerned.

(8) See also THEORIES OF LEARNING, 3RD EDITION, Hilgard, E. R. and Bower, G. H., Appleton-Century-Crofts, New York, 1966, pp. 562-565.

(9) CONSTRUCTING INSTRUCTION BASED ON BEHAVIORAL OBJECTIVES, Walbesser, Kurtz, Gross, Robl. (Available from School of Engineering, Oklahoma State University, Stillwater, Oklahoma, 74074)

(10) Professor J. G. Sherman, Georgetown University, Washington, D.C., is editing a PSI Newsletter as a clearinghouse for teachers who are interested in or have developed topics or courses using the proctorial system. Anyone interested should write Dr. Sherman.